September 30, 2005

PELAGIC ORGANISM DECLINE ELEMENT PRELIMINARY FINDINGS AND PROGRESS REPORT

Title: Pathobiological Investigation to Determine the Condition of Field Collected 2005 Striped Bass and a Pilot Study to determine the Location and Effects of Bioavailable Lipophilic Compounds in the San Francisco Estuary

Submitted by:

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The Interagency Ecological Program (IEP) reported a step change (decline) in the populations of pelagic fish species in the San Francisco Estuary in 2001. In addition, IEP abundance indices calculated for these pelagic fish species and zooplankton over the past three years suggest that significant declines in these populations continue. The extremely low population numbers that have been reported were not anticipated given the stability of environmental factors such as climate and hydrology during this period. Consequently, IEP is augmenting existing monitoring and research programs to investigate population declines of pelagic biota to determine if a new threat to these pelagic fish or their prey has emerged, and to examine the underlying causes for the recent biotic declines. A conceptual model has been constructed based on three factors acting individually or in concert to lower pelagic productivity. They are: 1) contaminants, 2) introduced or invasive species, and 3) water project operations including diverting water for use in Southern California. A *triage* approach was chosen for 2005 to gain preliminary information that could identify potential causes of these population declines, and to help prioritize future investigations.

In response to the *triage* approach undertaken by the IEP-POD management team, our laboratory was asked to investigate potential causes for the decline of the striped bass population. Investigations focused on determining the health and condition of striped bass collected during the summer of 2005. In addition, our laboratory responded to the IEP-POD management teams request for information regarding the decline of pelagic fishes by utilizing our resources to undertake a pilot study to determine the location and effects of bioavailable lipophilic compounds in the San Francisco Estuary and by beginning work on a dose (stressor)-structured population dynamics model for striped bass. Contained herein are preliminary findings and progress to-date.

Randall Baxter of DFG/PODMT provided a boat and crew to collect striped bass for biochemical and histological analyses on August 30, 2005. Three fish per station were collected and organs snap frozen for biochemical analysis at stations 508 (Suisun Bay, off Chipps Island, opposite Sacramento North Ferry Slip), 602 (Grizzly bay northeast of Suisun slough at dolphin) and 703 (lower Sacramento River, upstream from the San Joaquin confluence and immediately north of Sherman Lake). Additionally, 9 striped bass were collected from station 602 and 12 from station 703 and fixed in formalin for routine histopatholgical analysis (table I). Otoliths were removed and archived from these fish for subsequent age/growth analyses.

The 12 striped bass collected from station 703 and the 9 striped bass collected from station 602 have been evaluated via routine histopathology (see detailed pathology report following). These samples will also be evaluated for P4501A1 induction (enzyme system induced via specific classes of contaminants) using immunohistochemical methods. Immunohistochemical results from these samples should be available by the end of October 2005.

On September 1, 2005, DFG delivered 36 additional striped bass samples collected during the townet survey conducted in August (table II). These samples have been processed for routine histopathology and are currently being evaluated. Otoliths were removed and archived for subsequent age/growth analyses. Results from routine histopathological analyses should be available by late October 2005. In addition, on September 16, 2005, S.J. Teh's lab delivered striped bass samples (n=169) collected by DFG during the months of June and July 2005 (Table III). A subset of these fish will be subjected to routine histopathological and P450 immunohistochemical analyses with results available by December 31, 2005 or sooner. Otoliths will be removed from this subset and archived for age/growth analyses.

PROGRESS ON THE PILOT STUDY

A pilot study to determine the location and effects of bioavailable lipophilic compounds in the San Francisco Estuary commenced on August 16, 2005 with the deployment of semipermeable membrane devices (SPMDs) at three locations within the estuary system. Devices were deployed (i) in the Napa River (control site for *Microcystis* sp.) just below the new bridge under construction, (ii) Collinsville, at the Bureau of Reclamation's monitoring pier, and (iii) in Sand Mound Slough near the intersection of Piper Slough. The three SPMDs were successfully retrieved intact on September 13, 2005 and immediately sent to Environmental Sampling Technologies Labs (EST) for processing required under U.S. Patent 5,098,573 and 5,395,426. EST Labs received the SPMDs on September 15, 2005. EST labs processed the devices and sent the extracted materials to Dave Crane at the California Department of Fish and Game's Fish and Wildlife Water Pollution Control Laboratory on September 22, 2005. The extracts from the SPMDs are currently being split into two groups, one for chemical analysis and the other for use *in vivo* toxicity testing. This testing will determine physiological responses to bioavailable environmental contaminants from deployment sites. Experiments on juvenile striped bass are scheduled to be performed during the week of October 17, 2005. Preliminary results of this study should be available by December 31, 2005.

PROGRESS ON THE MODELING EFFORTS

We have developed a preliminary model of striped bass movement in the Bay-Delta using a 2-Dimensional Biased Levy Flight Model. In general terms, Levy flight motion consists of sequential straight runs with constant velocity followed by tumbling events, which are arbitrary changes in direction by an angle, defined as "turn angle". The run-time, velocity of each run, and turn angle, are treated as random variables that obey certain probability distribution functions (PDFs). Two different mechanisms for simulating the bias motion of fish are implemented in the model. The first mechanism super-imposes an advective velocity component to the random velocity generated by the run and tumble model. This advective velocity reflects the flow and direction of fluid driving the motion of larvae from the spawning grounds to the Bay-Delta. The second component governing biased motion of striped bass is the preferential use of particular habitats, a concept similar to chemotaxis in bacterial motility. Specifically, the run-times toward preferential habitats are longer than towards less favorable conditions. The boundaries of the water body were discretized into a structured grid using a computer program written in Visual C++. The code is capable of automatically reading DXF files directly extracted from ARCGIS shape files. When a fish encounters a boundary in the model, a tumble event is immediately initiated.

The entire model was coded in Visual C++ and calibrated with empirical fish distribution data collected using either Townet or Midwater trawls (Figure 1); the data is available through IEP at http://wwwiep.water.ca.gov/. The model output is represented as a movie illustrating fish densities spatially and temporally over the course of a year; the output is not shown here given the difficulty of conveying a time-series of images on paper. The model will be further refined and integrated with contaminant data (both in sediments and water) in the subsequent year to obtain a quantitative estimate of contaminant exposure within striped bass populations in the Bay-Delta region. The model can also be incorporated into spatial and temporal locations of other biotic and abiotic factors, such as prey location and habitat quality, to investigate the impact of other stressors present in the POD 2005 Conceptual Model. Specific applications of the model will be explored with IEP in the coming months.

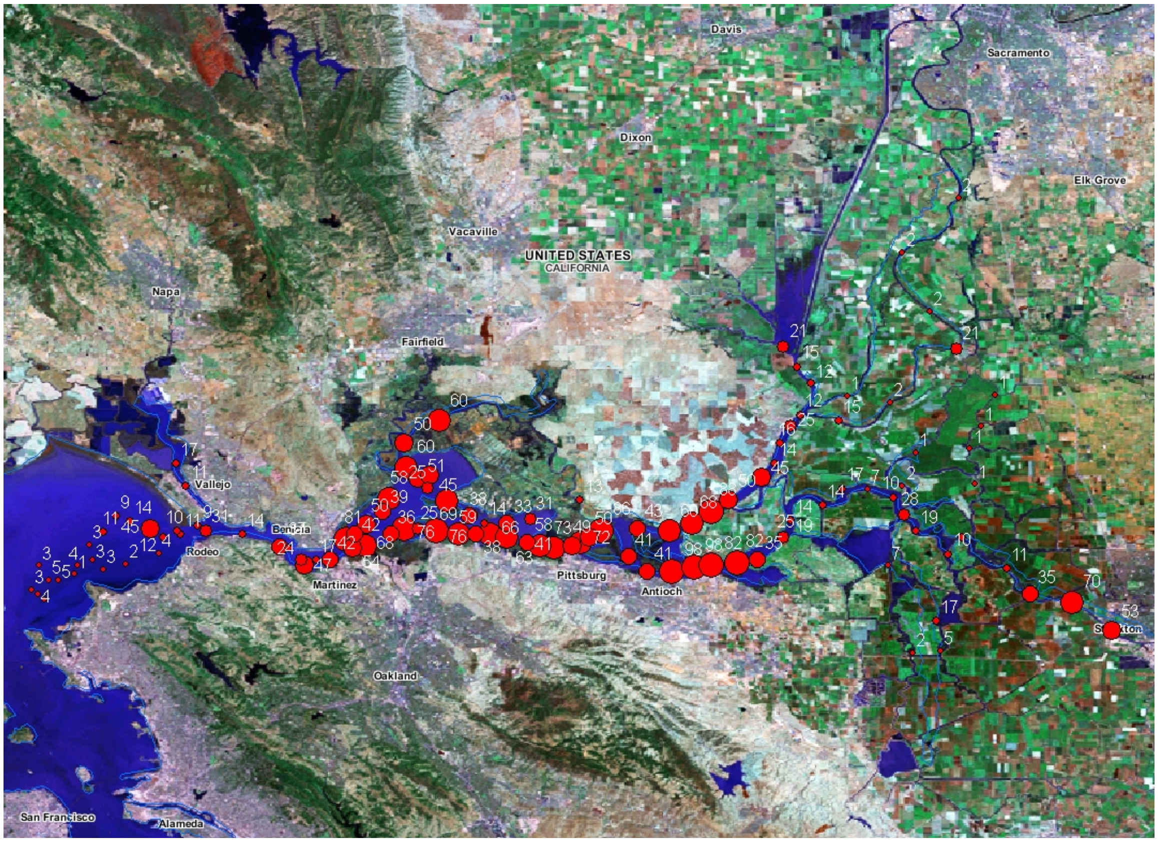

Figure 1. Location of striped bass in the Bay Delta in 1993. The red circles represent relative proportions of fish numbers at specified sample locations (large dots represent larger quantities of fish). The model out (not shown here) can be visualized as an animated series of red masses moving throughout the estuary spatially over time.

SUMMARY OF PATHOLGICAL FINDINGS

Findings in this limited sample of juvenile striped bass included: protozoan parasitic infection of the gills; metazoan parasitic infection of the internal viscera; coccidian infection of the intestine; accumulation of eosinophilic droplets within the proximal renal tubules; submucosal gastritis of the nonglandular stomach (highly exaggerated of unknown etiology and we have not seen this condition in any striped bass we have previously evaluated); and a rare epitheliocystis infection of the gill in three striped bass. An evaluation of the various findings in these juvenile striped bass from Stations 602 and 703 should be considered cumulatively in the context of the various findings rather than an evaluation of a single finding in an individual fish. For example, it is not uncommon nor is it unexpected to find mild parasitic infections in wild fishes and conversely it would be unusual to find the absence of parasitic infections in wild fish. However, if the various findings in these fish are considered cumulatively and from a population perspective, they suggest that the combination of mild or moderate lesions and infectious conditions may compromise individual fish within the population, thus leading to morbidity and mortality within the population. The cumulative effects of these conditions are likely further exacerbated if the population is subsequently exposed to additional stressors such as adverse environmental conditions or chronic toxic insults. Also, these various preliminary findings, if considered cumulatively, may also indicate that the population has been already compromised by stressors such as adverse or less than ideal environmental conditions or exposure to a single or multiple toxicants that have subsequently resulted in additional noninfectious and/or infectious lesions or conditions. Furthermore, these findings should not be initially dismissed as non-significant without further evaluations of additional fish collected during this study period (which is in progress), since population surveys in the last several years have indicated very low population numbers over the past several years including a recent report (August 2005) from California Department of Fish and Game staff that indicated extremely low numbers of juvenile striped bass were collected during the recent survey period. It is important to note that these juvenile fish were survivor fish that may have represented the more robust or healthy members of the population that did not succumb to the effects of these disease conditions and/or an epizootic. Regardless, additional examination of juvenile fish from various geographic locations is recommended in the future to determine the extent and severity of these various conditions on the population. Analyses should not only include histological examination of juvenile fish, but also the examination of live fish including the collection of fresh tissues for identification of infectious agents; electron-microscopic examination of selected tissues; additional histochemical and immuonohistohemical techniques; and a more detailed and continual assessment of environmental conditions and the potential exposure to toxicants. In this context, the induction of P450 enzymes in the tissues of these fish from Stations 602 and 703 using immunohistochemical methods is currently in progress. In addition, histochemical and electron-microscopic diagnostic techniques are currently being used to further evaluate the coccidian and epitheliocystis infections in these fish. Results from these analyses will be reported when completed.

Pathology Report
Specific details of the pathological analyses are provided below which form the basis of the above summary.

Pathology No.: 05S0596

Date of submission: August 30, 2005
Date of report: September 30, 2005

Species: Striped Bass
Station No.: 703

Diagnoses:
1) Branchitis, mild (Fish #4, 8 and 10-11) to moderate (Fish #6), multifocal, epithelial, lamellar, protozoal (possible sessile ciliates or trichodinids); striped bass (see comment)
2) Hepatopathy, diffuse; due to condensation of the hepatocytic cytoplasm (=loss of cytoplasmic glycogen) (see comment)
3) Presumptive gastritis, moderate to severe, focally extensive, subacute to chronic, submucosal, nonglandular stomach; with a similar but less severe (mild to moderate and multifocal) involvement of the mucosal/submucosal glandular stomach (see comment)

4) Coelomitis, mild (rare to occasional), granulomatous; with the formation of discrete granulomas within the coelomic membranes; due to an undetermined (Fish #1-2 and 7) or metazoan parasitic etiology (Fish #5 and 12; see comment)
5) Hepatitis, mild, multifocal, granulomatous; with the formation of discrete granulomas due to an undetermined etiology (Fish #6; see comment)
6) Hepatitis, moderate, focal, subacute to chronic, perivascular, nonsuppurative; Fish #8; not significant
7) Branchitis, rare, epithelial, lamellar; presumptive bacterial (=chlamydial) etiology (see comment)

History: Twelve (12) whole juvenile striped bass that were collected from the Sacramento-San Joaquin Delta at Station No. 703 were submitted in formalin for microscopic examination.

Microscopic examination: Multiple tissues from twelve (12) striped bass were examined according to the slide designation as follows:
Fish #1: length=17.5 cm/weight=55.5 grams/slidesT1-2;
Fish #2: length=16.8 cm/weight=47.5 grams/slides T3-4;
Fish #3: length=20.1 cm/weight=82.7 grams/slides T5-6;
Fish #4: length=23.5 cm/weight=136.5 grams/slides T7-9;
Fish #5: length=24.3 cm/weight=138 grams/slides T10-11;
Fish #6: length=20.0 cm/weight86.7 grams/slides 12-13;
Fish #7: length=18.8 cm/weight=73.1 grams/slides T14-15;
Fish #8: length=17.2 cm/weight=52.5 grams/slides T16-17;
Fish #9 (Small Fish #1): length=9.5 cm/weight=8.2 grams/slides T18-19;
Fish #10 (Small Fish #2): length=9.5 cm/weight=8.0 grams/slides T20-21;
Fish #11 (Small Fish #3): length=11.5 cm/weight=15.5 grams/slides T22-23; and
Fish #12 (Small Fish #4): length=8.6 cm/weight=6.2 grams/slides T24-25.

Fish #1

There was a diffuse condensation of the hepatocytic cytoplasm due to the loss of cytoplasmic vacuolization (=loss of cytoplasmic glycogen). There was a moderate to severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. There was a single, large, discrete granuloma within the coelomic membranes.

Fish #2

There was a moderate to severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. There were two (2) discrete granulomas within the coelomic membranes.

Fish #3

There was a diffuse condensation of the hepatocytic cytoplasm due to the loss of cytoplasmic vacuolization (=loss of cytoplasmic glycogen). There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach.

Fish #4

There was a mild, multifocal loss of hepatocytic cytoplasmic vacuolization (=loss of cytoplasmic glycogen). There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. There was a mild, multifocal, protozoan parasitic infection of the branchial lamellae; the apparent protozoan parasites had profiles that were suggestive of possible sessile ciliates.

Fish #5

There was a diffuse condensation of the hepatocytic cytoplasm due to the loss of cytoplasmic vacuolization (=loss of cytoplasmic glycogen). There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. There was a single discrete granuloma within the coelomic membranes that contained a metazoan parasite.

Fish #6

There was a diffuse condensation of the hepatocytic cytoplasm due to the loss of cytoplasmic vacuolization (=loss of cytoplasmic glycogen). There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. There were occasional small, discrete granulomas within the liver. There was also a moderate, multifocal, protozoan parasitic infection of the branchial lamellae; the apparent protozoan parasites had profiles that were suggestive of trichodinid ciliates.

Fish #7

There was a diffuse condensation of the hepatocytic cytoplasm due to the loss of cytoplasmic vacuolization (=loss of cytoplasmic glycogen). There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. There was a single, large, discrete granulomas within the coelomic membranes.

Fish #8

There was a diffuse condensation of the hepatocytic cytoplasm due to the loss of cytoplasmic vacuolization (=loss of cytoplasmic glycogen). There was also a moderate, focal, subacute to chronic, perivascular, nonsuppurative hepatitis in this fish. There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. A single lamellar protozoan parasite that was suggestive of a possible sessile ciliate was observed in this fish.

Fish #9

There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach.

Fish #10

There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. There was also a mild, multifocal, protozoan parasitic infection of the branchial lamellae; the apparent protozoan parasites had profiles that were suggestive of trichodinid ciliates.

Fish #11

There was a diffuse condensation of the hepatocytic cytoplasm due to the loss of cytoplasmic vacuolization (=loss of cytoplasmic glycogen). There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. There was a mild, multifocal, protozoan parasitic infection of the branchial lamellae; the apparent protozoan parasites had profiles that were suggestive of possible sessile ciliates. There was also a single enlarged cells of the lamellar epithelium that was further characterized by an abundance of dense basophilic cytoplasm that was consistent with an intracellular bacterial (=chlamydial) infection that is often referred to as epitheliocystis infection.

Fish #12

There was a severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild to moderate and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach. There were rare discrete granulomas within the coelomic membranes that contained metazoan parasites. There were two (2) enlarged cells of the lamellar epithelium that were further characterized by an abundance of dense basophilic cytoplasm that was consistent with an intracellular bacterial (=chlamydial) infection that is often referred to as epitheliocystis infection.

Comment: These juvenile striped bass were generally in good condition and were apparently feeding normally based on the abundance of ingesta within the alimentary tract. The observation of diffuse condensation of the hepatocytes in the majority of these fish was included for completeness, but should not be construed as an abnormal finding or lesion since there is generally minimal or marginal hepatic storage of glycogen in rapidly growing juvenile fish. In addition, hepatic reserves of glycogen may be rapidly depleted during capture (=stress response) and may also be depleted as a consequence of a prolonged postmortem interval and/or inadequate fixation of the liver. The etiology of the moderate, focal, subacute to chronic, perivascular, nonsuppurative hepatitis in Fish #8 could not be determined by histological examination, although this was considered an anecdotal finding and was not considered a significant finding.

The occurrence of rare to occasional discrete granulomas within the coelomic cavity of several fish (Fish #1-2, 5, 7 and 12) and the liver of one (1) fish (Fish #6) was not an unexpected finding, since granulomas are not an uncommon finding in wild fishes that may occur due to various infectious or noninfectious etiologies. In these fish, the granulomas were due to metazoan parasitic infections in two (2) fish (Fish #5 and 12), which is not an unexpected finding in wild fish, whereas the etiology of the granuloma formation in several additional fish (Fish #1-2 and 6-7) could not be determined by histological examination.

Concerning the apparent severe, focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach and a similar but less severe (mild and multifocal) accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the basal mucosa and subjacent submucosa of the glandular stomach, these findings should be interpreted in a conservative context. Specifically, although the accumulation of mononuclear inflammatory cells within the gastric submucosa in these fish was apparently excessive, the presence of mononuclear inflammatory cells or lymphoid cells are a normal occurrence within the submucosa of the gastrointestinal tract of vertebrates including fishes as a consequence of antigen exposure and processing in these sites. Therefore, the apparent excessive accumulation of these cell types within the gastric submucosa of these fish may only be a normal finding in immunologically naive juvenile fish that are being exposed to various antigens via the ingesta.

The most significant finding in these fish was the branchial protozoan infection in several fish that was consistent with a sessile ciliate infection in three (3) fish (Fish #4, 8, and 11) and a motile ciliate infection that was consistent with a trichodinid infection in two (2) fish (Fish # 6 and 10). Regardless of the specific protozoan parasite, the infections were generally considered as rare or mild infections, except in Fish #6 that had a moderate infection. However, it should be understood that the antemortem severity of external parasitic infections cannot be definitively determined by histological examination, since external parasitic agents will generally leave the

host following death of the host or will be removed from the tissue following fixation of the tissues. In this context, a more definitive determination of the severity of infection can only be determined by the cytological examination of branchial preparations using branchial tissue obtained from live fish or fish immediately following euthanasia. In addition, a definitive identification of the protozoan parasites cannot be performed on histological sections but also requires cytological preparations.

Finally, the rare occurrence of enlarged lamellar epithelial cells in two (2) fish (Fish #11-12) that were further characterized by an abundance of dense basophilic cytoplasm, which was consistent with an intracellular bacterial (=chlamydial) infection that is often referred to as epitheliocystis infection, was an interesting finding but was not considered a significant finding in these individual fish due to the rare occurrence of these cells. Regardless of the significance, a definitive etiological diagnosis requires electron-microscopic examination of these cells, which can be performed for completeness as necessary. In addition, the induction of P450 enzymes in the gills of these fish using immunohistochemical methods is currently in progress and will be reported upon completion of this analysis.

In summary, an evaluation of the various findings in the juvenile striped bass from Stations 602 and 703 should be considered cumulatively in the context of the various findings rather than an evaluation of a single finding in an individual fish. For example, it is not uncommon nor is it unexpected to find mild parasitic infections in wild fishes and conversely it would be unusual not to find parasitic infections in wild fish. However, if the various findings in these fish are considered cumulatively and from a population perspective, these various findings suggest that the combination of mild or moderate lesions including mild to moderate infectious conditions may compromise individual fish within the population that may eventually result in morbidity and mortality within the population especially if the population is subsequently exposed to additional stressors such as adverse environmental conditions or chronic toxic insults. Also, these various findings if considered cumulatively may also indicate that the population has been compromised by stressors such as adverse or less than ideal environmental conditions or exposure to a single or multiple toxicants that has subsequently resulted in additional noninfectious and/or infectious lesions or conditions. Regardless, additional examination of juvenile fish from various geographic locations is recommended in the future to determine the extent and severity of these various conditions on the population that should not only include histological examination of juvenile fishes but also the examination of live fish and a more detailed assessment of environmental conditions and the potential exposure to toxicants. Please contact for additional information as necessary. Please contact for additional information as necessary.

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Pathology Report 2

Pathology No.: 05S0598

Date of submission: August 30, 2005
Date of report: September 29, 2005

Species: Striped Bass
Station No.: 602

Diagnoses:
1) Branchitis, mild (Fish #2, 4-6, 7 and 9) to moderate (Fish #8), multifocal, epithelial, lamellar, protozoal (apparent sessile ciliates or trichodinids); and a mild (rare), multifocal, oropharyngeal protozoan parasitic infection (Fish #1); striped bass (see narrative and comment)
2) Coccidiosis, mild (Fish #1, 7 and 9) to moderate (Fish #5-6), enteric; anterior intestine
3) Intracytoplasmic accumulation of eosinophilic droplets, mild to moderate, multifocal, proximal renal tubules (Fish #1-2 and 4-9) (see narrative and comment)
4) Presumptive gastritis, mild (Fish #7-8) or moderate to severe (Fish #1-5), focally extensive, subacute to chronic, submucosal, nonglandular stomach
5) Coelomitis, mild (rare to occasional), granulomatous; with the formation of discrete granulomas within the coelomic cavity; metazoan parasitic etiology (Fish #2-3 and Fish #8-9)
6) Hepatitis, mild, multifocal, granulomatous; with the formation of discrete granulomas; metazoan parasitic etiology (Fish #5)
7) Branchitis, rare, epithelial, lamellar; presumptive bacterial (=chlamydial) etiology; Fish #4
8) Myositis, moderate, focally extensive, chronic, necrotizing; dorsoventral muscle fibers that were subjacent to the opercular cavity; etiology not determined; (Fish #3)

History: Nine (9) whole juvenile striped bass that were collected from the Sacramento-San Joaquin Delta at Station No. 602 were submitted in formalin for microscopic examination. Please refer to Pathology Report 05S0596 for additional information related to striped bass that were examined from Station No. 703.

Microscopic examination: Mid-sagittal sections of nine (9) striped bass were examined according to the slide designation as follows:
Fish #1(a): length=5.8 cm/weight=1.5 grams/slide T1;
Fish #2(b): length=7.8 cm/weight=4.2 grams/slide T2;
Fish #3(c): length=6.8 cm/weight=3.0 grams/slide T3;
Fish #4(d): length=6.8 cm/weight=3.5 grams/slide T4;
Fish #5(e): length=7.4 cm/weight=4.0 grams/slide T5;
Fish #6(f): length=8.4 cm/weight=5.8 grams/slide T6;
Fish #7(g): length=6.7 cm/weight=2.4 grams/slide T7

Fish #8(h): length=6.0 cm/weight=1.9 grams/slide T8; and
Fish #9(i): length=6.6 cm/weight=2.6 grams/slide T9.

The findings in these juvenile striped bass from Station No. 602 were similar to the findings that were reported for the twelve (12) juvenile striped bass that were examined from Station No. 703; please refer to Pathology Report 05S0596 for additional information. There was a normal amount of intracytoplasmic glycogen within the hepatocytes of these nine fish. However, there was a mild (Fish #7-8) or moderate to severe (Fish #1-5), focally extensive, submucosal accumulation of mononuclear inflammatory cells with occasional eosinophilic granular cells within the nonglandular stomach at the gastropyloric junction. There were occasional granulomas that contained metazoan parasites within the coelomic cavity of four (4) fish (Fish #2-3 and Fish #8-9) and the liver of one (1) fish liver (Fish #5).

There was a mild (rare), multifocal, protozoan parasitic infection of the oropharynx in one (1) fish (Fish #1) and a mild (Fish #2, 4-6, 7 and 9) to moderate (Fish #8) multifocal, protozoan parasitic infection of the branchial lamellae in seven (7) fish; the apparent protozoan parasites had profiles that were generally suggestive of sessile ciliates (Fish #1, 4-6, and 7-9) or trichodinid ciliates (Fish #2). There was also a single enlarged cell of the lamellar epithelium in one (1) fish (Fish #4) that was further characterized by an abundance of dense basophilic cytoplasm that was consistent with an intracellular bacterial (=chlamydial) infection that is often referred to as epitheliocystis infection.

Additional findings in these striped bass from Station No. 602 that were not observed in the striped bass from Station No.703 included the intracytoplasmic accumulation of eosinophilic droplets of the proximal renal tubules and an intestinal coccidian infection. Specifically, there was a mild to moderate, multifocal, intracytoplasmic accumulation of dense, homogeneous, eosinophilic droplets within the cytoplasm of the proximal renal tubules in eight (8) fish (Fish #1-2 and 4-9). There was also a mild (Fish #1, 7 and 9) to moderate (Fish #5-6) coccidian infection of the anterior intestine in five (5) fish that was characterized by the intraepithelial presence of macrogametes and mature oocysts.

Finally, there was a moderate, focally extensive, chronic, necrotizing myositis of the dorsoventral muscle fibers that were subjacent to the opercular cavity in one (1) fish (Fish #3), although the etiology of this myositis could not be determined by routine histological examination and was only considered an anecdotal finding in a single fish.

Comment: Please refer to the comments included with Pathology Report 05S0596 for a discussion concerning the findings in these striped bass from Station No. 602 that were similar to the findings in the striped bass from Station No. 703. In addition, the intracytoplasmic accumulation of eosinophilic droplets is not an uncommon finding in various fishes (wild or captive and freshwater or marine species) and is generally considered a normal finding due to protein absorption of the proximal renal tubules from the glomerular filtrate. However, in higher vertebrates (mammals), the presence of intracytoplasmic protein droplets is generally associated with protein absorption due to a glomerulopathy that results in the loss of protein in the glomerular filtrate, whereas in fishes the accumulation of eosinophilic droplets within the proximal renal tubules is generally not associated with glomerular lesions. However, some pathologists have considered that the loss of protein within the glomerular filtrate and the subsequent absorption of this protein in the proximal renal tubules may occasionally be associated with exposure to increased ammonia concentrations or exposure to toxicants. In this context, the observation of eosinophilic droplets within the proximal renal tubules of these juvenile striped bass should not be dismissed as a normal finding, but should be considered as a possible indicator of a toxic or environmental insult in these fish.

Also, the finding of enteric coccidiosis in these striped bass that was not observed in the striped bass from Station No. 703 was an interesting and significant finding, since moderate to severe coccidian infections can result in significant morbidity and mortality within populations, but especially populations of juvenile fish. Therefore, a more detailed examination to determine the extent and severity of the coccidiosis in populations of juvenile striped bass should be performed in the future including more detailed examinations to further identify the coccidian parasite.

In summary, an evaluation of the various findings in the juvenile striped bass from Stations 602 and 703 should be considered cumulatively in the context of the various findings rather than an evaluation of a single finding in an individual fish. For example, it is not uncommon nor is it unexpected to find mild parasitic infections in wild fishes and conversely it would be unusual not to find parasitic infections in wild fish. However, if the various findings in these fish are considered cumulatively and from a population perspective, these various findings suggest that the combination of mild or moderate lesions including mild to moderate infectious conditions may compromise individual fish within the population that may eventually result in morbidity and mortality within the population especially if the population is subsequently exposed to additional stressors such as adverse environmental conditions or chronic toxic insults. Also, these various findings if considered cumulatively may also indicate that the population has been compromised by stressors such as adverse or less than ideal environmental conditions or exposure to a single or multiple toxicants that has subsequently resulted in additional noninfectious and/or infectious lesions or conditions. Regardless, additional examination of juvenile fish from various geographic locations is recommended in the future to determine the extent and severity of these various conditions on the population that should not only include histological examination of juvenile fishes but also the examination of live fish and a more detailed assessment of environmental conditions and the potential exposure to toxicants. In this context, the induction of P450 enzymes in the tissues of these fish from Stations 602 and 703 using immunohistochemical methods is currently in progress and will be reported upon completion of this analysis. Please contact for additional information as necessary.

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TABLE I

Fish for dissection, samples (kidney, liver, spleen, muscle, brain, gills) flash frozen in LN2

Fish	Slide #	Station ID	Length (cm)	Weight (g)	Dissection	Otolith
FS1		508	9.5	9	+	2
FS2		508	18.1	57	+	2
FS3		602	7.7	4.2	+	2
FS4		602	7.8	4.8	+	2
FS5		602	8.6	6.5	+	2
FS6		703	9	7.5	+	2
FS7		703	8.5	6	+	2
FS8		703	7	3.5	+	2

Fish in formalin for histopathology.

Fish	Slide #	Station ID	Length (cm)	Weight (g)	Dissection	Otolith
1 (a)		602	5.8	1.5	+	2
2 (b)		602	7.8	4.2	+	2
3 (c)		602	6.8	3	+	2
4 (d)		602	6.8	3.5	+	2
5 (e)		602	7.4	4	+	2
6 (f)		602	8.4	5.8	+	2
7 (g)		602	6.7	2.4	+	2
8 (h)		602	6	1.9	+	2
9 (i)		602	6.6	2.6	+	2
1	T 1-2	703	17.5	55.5	+	
2	T 3-4	703	16.8	47.5	+	
3	T 5-6	703	20.1	82.7	+	
4	T 7-9	703	23.5	136.5	+	
5	T 10-11	703	24.3	138	+	2
6	T 12-13	703	20	86.7	+	2
7	T 14-15	703	18.8	73.1	+	2
8	T 16-17	703	17.2	52.5	+	2
9	T 18-19	703	9.5	8.2	+	
10	T 20-21	703	9.5	8	+	
11	T 22-23	703	11.5	15.5	+	
12	T 24-25	703	8.6	6.2	+	

TABLE II

Serial No.	Species	Fork length	Station	Date	Time	Histology	Otolith
2005-301	striped bass	82	707	8/9/2005	11:28	YES	2
2005-302	striped bass	17	707	8/9/2005	11:42	YES	0
2005-303	striped bass	23	804	8/10/2005	6:38	YES	0
2005-331	striped bass	42	610	8/11/2005	8:33	YES	1
2005-332	striped bass	25	610	8/11/2005	8:33	YES	1
2005-333	striped bass	37	610	8/11/2005	8:48	YES	1
2005-334	striped bass	18	610	8/11/2005	8:48	YES	1
2005-335	striped bass	20	610	8/11/2005	9:03	YES	1
2005-336	striped bass	27	609	8/11/2005	9:38	YES	1
2005-337	striped bass	22	609	8/11/2005	9:38	YES	1
2005-338	striped bass	40	609	8/11/2005	9:53	YES	1
2005-339	striped bass	29	609	8/11/2005	9:53	YES	1
2005-340	striped bass	26	609	8/11/2005	9:53	YES	1
2005-341	striped bass	29	609	8/11/2005	9:53	YES	0
2005-342	striped bass	37	609	8/11/2005	9:53	YES	0
2005-343	striped bass	77	609	8/11/2005	10:08	YES	2
2005-344	striped bass	31	609	8/11/2005	10:08	YES	1
2005-345	striped bass	25	609	8/11/2005	10:08	YES	1
2005-346	striped bass	42	606	8/11/2005	12:09	YES	1
2005-347	striped bass	85	602	8/11/2005	13:25	YES	2
2005-348	striped bass	79	602	8/11/2005	13:25	YES	2
2005-349	striped bass	68	602	8/11/2005	13:25	YES	1
2005-350	striped bass	74	602	8/11/2005	13:25	YES	1
2005-356	striped bass	65	602	8/11/2005	13:54	YES	2
2005-357	striped bass	65	602	8/11/2005	13:54	YES	1
2005-358	striped bass	59	602	8/11/2005	13:54	YES	2
2005-360	striped bass	30	707	8/23/2005	10:42	YES	1
2005-363	striped bass	57	706	8/23/2005	11:35	YES	1
2005-366	striped bass	66	504	8/24/2005	7:51	YES	1
2005-385	striped bass	64	610	8/25/2005	7:08	YES	1
2005-386	striped bass	34	610	8/25/2005	7:23	YES	1
2005-387	striped bass	50	610	8/25/2005	7:35	YES	2
2005-388	striped bass	30	610	8/25/2005	7:35	YES	2
2005-389	striped bass	25	610	8/25/2005	7:35	YES	0
2005-390	striped bass	70	606	8/25/2005	9:09	YES	1
2005-391	striped bass	67	602	8/25/2005	10:18	YES	1
2005-361	striped bass	n/a	n/a	n/a	n/a		1
2005-362	striped bass	n/a	n/a	n/a	n/a		1

TABLE III

Serial no.	Species	Jars	Fork length	Station	Date	Time	Histology	Otolith
2005-018	Striped Bass	19	20	610	6/16/2005	7:00		
2005-019	Striped Bass	19	29	610	6/16/2005	7:00		
2005-020	Striped Bass	19	20	610	6/16/2005	7:00		
2005-021	Striped Bass	19	18	610	6/16/2005	7:00		
2005-022	Striped Bass	19	22	610	6/16/2005	7:00		
2005-038	Striped Bass	19	32	609	6/16/2005	8:15		
2005-039	Striped Bass	19	30	609	6/16/2005	8:15		
2005-040	Striped Bass	19	25	609	6/16/2005	8:15		
2005-041	Striped Bass	19	21	609	6/16/2005	8:15		
2005-042	Striped Bass	19	19	609	6/16/2005	8:15		
2005-167	Striped Bass	19	22	610	7/14/2005	6:26		
2005-168	Striped Bass	19	15	610	7/14/2005	6:26		
2005-169	Striped Bass	19	16	610	7/14/2005	6:26		
2005-170	Striped Bass	19	19	610	7/14/2005	6:26		
2005-171	Striped Bass	19	21	610	7/14/2005	6:26		
2005-172	Striped Bass	19	18	610	7/14/2005	6:26		
2005-173	Striped Bass	19	15	610	7/14/2005	6:26		
2005-174	Striped Bass	19	28	610	7/14/2005	6:40		
2005-175	Striped Bass	19	26	610	7/14/2005	6:40		
2005-176	Striped Bass	19	25	610	7/14/2005	6:40		
2005-177	Striped Bass	19	16	610	7/14/2005	6:57		
2005-178	Striped Bass	19	35	610	7/14/2005	6:57		
2005-179	Striped Bass	19	25	610	7/14/2005	6:57		
2005-180	Striped Bass	19	22	610	7/14/2005	6:57		
2005-181	Striped Bass	19	28	610	7/14/2005	6:57		
2005-182	Striped Bass	19	26	610	7/14/2005	6:57		
2005-183	Striped Bass	19	33	610	7/14/2005	6:57		
2005-184	Striped Bass	19	19	610	7/14/2005	6:57		
2005-185	Striped Bass	19	15	610	7/14/2005	6:57		
2005-186	Striped Bass	19	15	610	7/14/2005	6:57		
2005-187	Striped Bass	19	16	609	7/14/2005	7:26		
2005-188	Striped Bass	19	25	609	7/14/2005	7:26		
2005-189	Striped Bass	19	38	609	7/14/2005	7:26		
2005-190	Striped Bass	19	37	609	7/14/2005	7:41		
2005-191	Striped Bass	19	43	609	7/14/2005	7:41		
2005-192	Striped Bass	19	33	609	7/14/2005	7:41		
2005-193	Striped Bass	19	37	609	7/14/2005	7:41		
2005-194	Striped Bass	19	39	609	7/14/2005	7:41		
2005-195	Striped Bass	19	26	609	7/14/2005	7:41		
2005-196	Striped Bass	19	19	609	7/14/2005	7:41		
2005-197	Striped Bass	19	24	609	7/14/2005	7:41		
2005-198	Striped Bass	19	20	609	7/14/2005	7:41		
2005-199	Striped Bass	19	27	609	7/14/2005	7:41		
2005-200	Striped Bass	19	15	609	7/14/2005	7:55		

This is a draft work in progress subject to review and revision as information becomes available.

2005-201	Striped Bass	19	33	609	7/14/2005	7:55		
2005-202	Striped Bass	19	34	609	7/14/2005	7:55		

Serial no.	Species	Jars	Fork length	Station	Date	Time	Histology	Otolith
2005-203	Striped Bass	19	34	609	7/14/2005	7:55		
2005-204	Striped Bass	19	29	609	7/14/2005	7:55		
2005-205	Striped Bass	19	20	609	7/14/2005	7:55		
2005-206	Striped Bass	19	24	609	7/14/2005	7:55		
2005-207	Striped Bass	19	36	606	7/14/2005	8:24		
2005-208	Striped Bass	19	49	606	7/14/2005	8:24		
2005-209	Striped Bass	19	20	606	7/14/2005	8:24		
2005-210	Striped Bass	19	34	606	7/14/2005	8:37		
2005-211	Striped Bass	19	23	606	7/14/2005	8:37		
2005-212	Striped Bass	19	54	606	7/14/2005	8:51		
2005-213	Striped Bass	19	37	606	7/14/2005	8:51		
2005-214	Striped Bass	19	35	606	7/14/2005	8:51		
2005-059	Striped Bass	19	20	606	6/16/2005	9:22		
2005-060	Striped Bass	19	25	606	6/16/2005	9:22		
2005-061	Striped Bass	19	24	606	6/16/2005	9:22		
2005-062	Striped Bass	19	18	606	6/16/2005	9:22		
2005-063	Striped Bass	19	22	606	6/16/2005	9:22		
2005-246	Striped Bass	23	23	704	7/26/2005	13:20		
2005-247	Striped Bass	23	19	704	7/26/2005	13:20		
2005-248	Striped Bass	23	16	704	7/26/2005	13:20		
2005-261	Striped Bass	23	19	610	7/28/2005	7:50		
2005-262	Striped Bass	23	20	610	7/28/2005	7:50		
2005-263	Striped Bass	23	55	609	7/28/2005	8:50		
2005-264	Striped Bass	23	28	609	7/28/2005	8:50		
2005-265	Striped Bass	23	40	609	7/28/2005	9:04		
2005-266	Striped Bass	23	43	609	7/28/2005	9:04		
2005-267	Striped Bass	23	33	609	7/28/2005	9:04		
2005-268	Striped Bass	23	37	609	7/28/2005	9:04		
2005-269	Striped Bass	23	22	609	7/28/2005	9:04		
2005-270	Striped Bass	23	18	609	7/28/2005	9:18		
2005-271	Striped Bass	23	20	609	7/28/2005	9:18		
2005-272	Striped Bass	23	27	609	7/28/2005	9:18		
2005-273	Striped Bass	23	28	609	7/28/2005	9:18		
2005-274	Striped Bass	23	30	609	7/28/2005	9:18		
2005-092	Striped Bass	23	17	610	6/30/2005	6:54		
2005-093	Striped Bass	23	20	610	6/30/2005	6:54		
2005-094	Striped Bass	23	27	610	6/30/2005	6:54		
2005-095	Striped Bass	23	24	610	6/30/2005	6:54		
2005-096	Striped Bass	23	35	610	6/30/2005	6:54		
2005-097	Striped Bass	23	25	610	6/30/2005	6:54		
2005-098	Striped Bass	23	23	610	6/30/2005	6:54		
2005-099	Striped Bass	23	20	610	6/30/2005	6:54		
2005-100	Striped Bass	23	48	610	6/30/2005	7:09		
2005-101	Striped Bass	23	28	610	6/30/2005	7:09		

2005-102	Striped Bass	23	28	610	6/30/2005	7:09		

Serial no.	Species	Jars	Fork length	Station	Date	Time	Histology	Otolith
2005-103	Striped Bass	23	27	610	6/30/2005	7:23		
2005-104	Striped Bass	23	32	610	6/30/2005	7:23		
2005-105	Striped Bass	23	32	609	6/30/2005	7:49		
2005-106	Striped Bass	23	35	609	6/30/2005	7:49		
2005-107	Striped Bass	23	37	609	6/30/2005	7:49		
2005-108	Striped Bass	23	28	609	6/30/2005	7:49		
2005-109	Striped Bass	23	28	609	6/30/2005	7:49		
2005-110	Striped Bass	23	24	609	6/30/2005	7:49		
2005-111	Striped Bass	23	25	609	6/30/2005	7:49		
2005-112	Striped Bass	23	16	609	6/30/2005	7:49		
2005-113	Striped Bass	23	34	609	6/30/2005	8:03		
2005-114	Striped Bass	23	33	609	6/30/2005	8:03		
2005-115	Striped Bass	23	34	609	6/30/2005	8:03		
2005-116	Striped Bass	23	30	609	6/30/2005	8:03		
2005-117	Striped Bass	23	29	609	6/30/2005	8:03		
2005-118	Striped Bass	23	27	609	6/30/2005	8:03		
2005-119	Striped Bass	23	27	609	6/30/2005	8:03		
2005-120	Striped Bass	23	27	609	6/30/2005	8:03		
2005-121	Striped Bass	23	21	609	6/30/2005	8:03		
2005-122	Striped Bass	23	35	609	6/30/2005	8:16		
2005-123	Striped Bass	23	24	609	6/30/2005	8:16		
2005-124	Striped Bass	23	28	609	6/30/2005	8:16		
2005-125	Striped Bass	23	42	606	6/30/2005	8:43		
2005-126	Striped Bass	23	37	606	6/30/2005	8:43		
2005-127	Striped Bass	23	30	606	6/30/2005	8:43		
2005-128	Striped Bass	23	31	606	6/30/2005	8:43		
2005-129	Striped Bass	23	25	606	6/30/2005	8:43		
2005-130	Striped Bass	23	30	606	6/30/2005	8:43		
2005-131	Striped Bass	23	18	606	6/30/2005	8:43		
2005-132	Striped Bass	23	19	606	6/30/2005	8:43		
2005-133	Striped Bass	23	18	606	6/30/2005	8:43		
2005-134	Striped Bass	23	17	606	6/30/2005	8:43		
2005-135	Striped Bass	23	15	606	6/30/2005	8:43		
2005-136	Striped Bass	23	16	606	6/30/2005	8:43		
2005-137	Striped Bass	23	42	606	6/30/2005	8:56		
2005-138	Striped Bass	23	30	606	6/30/2005	8:56		
2005-139	Striped Bass	23	25	606	6/30/2005	8:56		
2005-140	Striped Bass	23	27	606	6/30/2005	8:56		
2005-141	Striped Bass	23	28	606	6/30/2005	8:56		
2005-142	Striped Bass	23	18	606	6/30/2005	8:56		
2005-143	Striped Bass	23	18	606	6/30/2005	8:56		
2005-144	Striped Bass	23	16	606	6/30/2005	9:10		
2005-154	Striped Bass	23	42	704	7/12/2005	11:12		

Serial no.	Species	Jars	Fork length	Station	Date	Time	Histology	Otolith
2005-310	Striped Bass	9	All the striped bass samples not in file					
2005-311	Striped Bass	9						
2005-312	Striped Bass	9		310-313, and 527 missing				
2005-313	Striped Bass	9						
2005-527	Striped Bass	9		One with no label				
2005-588	Striped Bass	9						
2005-604	Striped Bass	9						
2005-609	Striped Bass	9						
2005-712	Striped Bass	9						
2005-713	Striped Bass	9						
2005-714	Striped Bass	9						
2005-715	Striped Bass	9						
2005-716	Striped Bass	9						
2005-717	Striped Bass	9						
2005-718	Striped Bass	9						
2005-719	Striped Bass	9						
2005-720	Striped Bass	9						
2005-721	Striped Bass	9						
2005-733	Striped Bass	9						
2005-734	Striped Bass	9						
2005-735	Striped Bass	9						
2005-736	Striped Bass	9						
2005-737	Striped Bass	9						
2005-738	Striped Bass	9						
2005-739	Striped Bass	9						
2005-740	Striped Bass	9						
2005-741	Striped Bass	9						
2005-742	Striped Bass	9						
2005-743	Striped Bass	9						
2005-744	Striped Bass	9						
2005-745	Striped Bass	9						
2005-746	Striped Bass	9						
2005-759	Striped Bass	9						
2005-760	Striped Bass	9						
2005-761	Striped Bass	9						
2005-762	Striped Bass	9						
2005-763	Striped Bass	9						
2005-764	Striped Bass	9						
2005-765	Striped Bass	9						
2005-766	Striped Bass	9						
2005	Striped Bass	9						